Optical Coherence Tomography for reticle back-side inspection

Peter van der Walle, Sjoerd Oostrom, Jasper Winters, Thomas Liebig, Rob Snel, Wouter Jonker, Bert van der Zwan
TNO, P.O. Box 155, 2600 AD, Delft, The Netherlands

TNO innovation for life

ICCC INTERNATIONAL CENTRE FOR CONTAMINATION CONTROL

Introduction

Particles present on the back-side of an EUVL reticle can cause yield loss, down-time, and damage to the reticle or chuck (Figure 1). The surface of the chuck is covered with pins that contact only a small fraction of the reticle surface. Therefore only particles that are higher than the length of the pins reach the chuck. Reticle back-side inspection before each time the reticle is loaded on a chuck is used to avoid problems with particles [1]. Ideally the inspection step should only give an alarm when a particle larger than the pin height is present. An accurate alarm signals when cleaning of the reticle is required, while unnecessary cleaning is avoided, extending the lifetime of the reticle.
Scatterometry-based inspection techniques show many detections on the back-side of a reticle when it has been chucked before [2]. Most of these detections are minor damage or contamination at the pin contact locations that cause no issues. However, with fast low resolution back-side inspection, clusters of these defects show as a single large defect, resulting in a false alarm.

We have designed a system that uses optical coherence tomography to avoid the inherent problems of scatterometry-based detection. This system detects the height of particles and therefore excludes the non-relevant detections seen with scatterometry.
Figure 2 explains the basic concept of spectral-domain OCT. Figure 3 shows a proof of concept measurement of a large particle on patterned surface. The reticle is inspected on the EUV inner-pod base-plate (Figure 4), leaving the front-side of the reticle unexposed and thus protected from contamination.

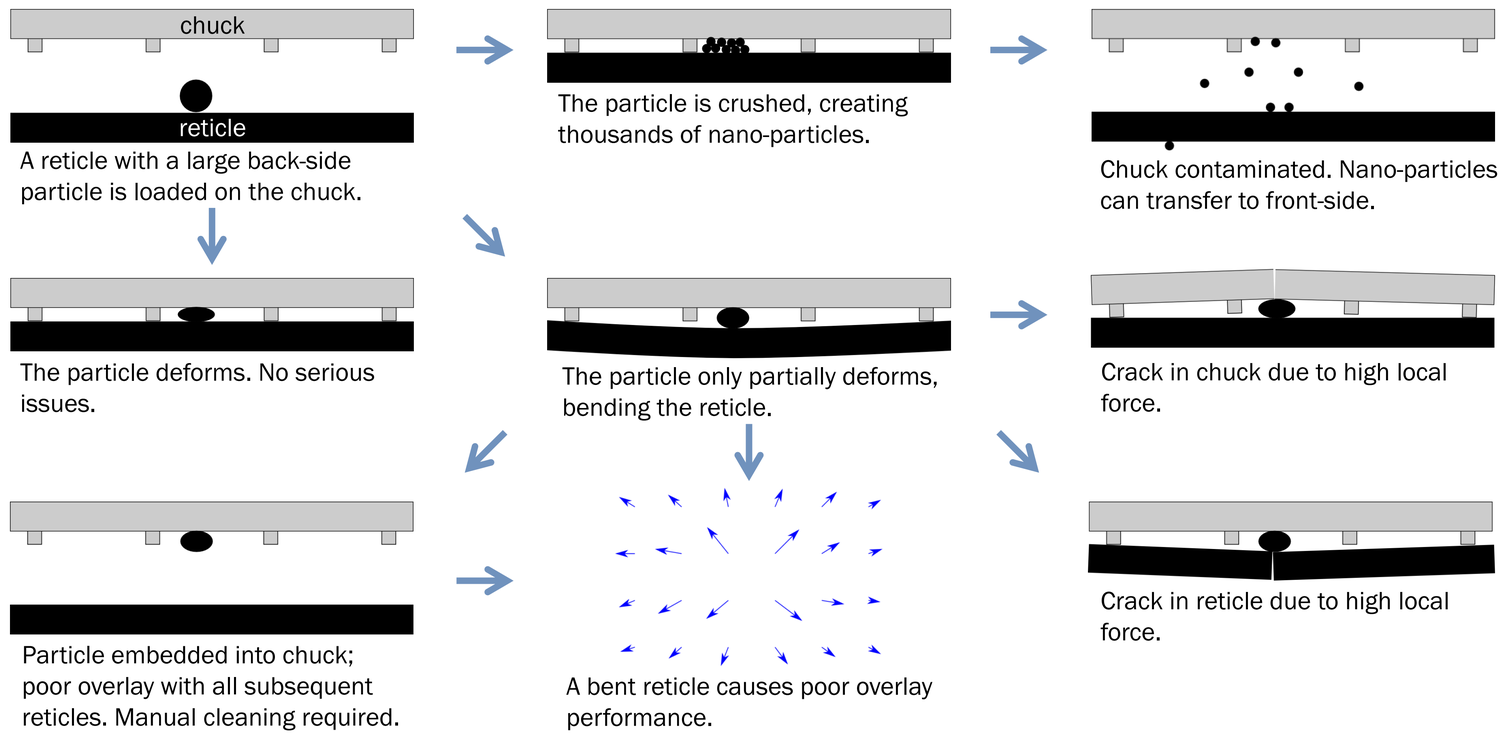


Figure 1: Loading a reticle with a large back-side particle on a chuck can lead to yield loss, down-time, and machine or reticle damage.

Advantages of OCT

- Directly measures the critical parameter: **particle height**
- Not sensitive to chuck pin damage or clusters of small particles
- Can distinguish between pits and bumps

Our design

- Optimal protection of the reticle front-side by inspection on the inner-pod base-plate
- Applicable in atmosphere (stand-alone/reticle-stocker) or vacuum (wafer-stepper)
- Height resolution 0.5 µm
- Spatial resolution 5 µm
- Inspection time < 2 minutes

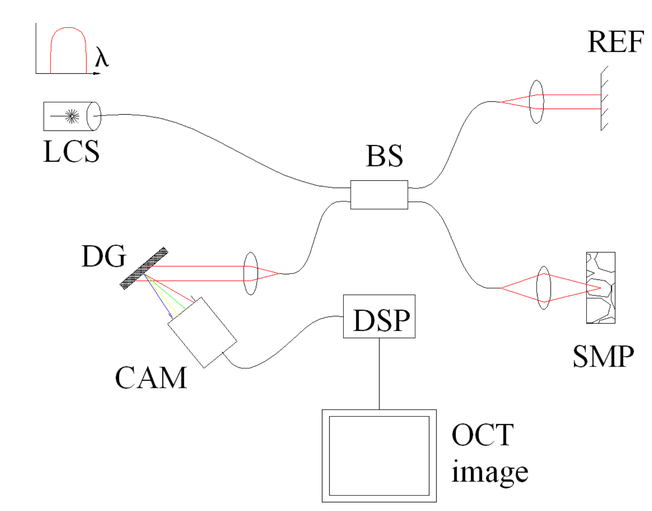


Figure 2: In a spectral domain OCT system a low-coherence source (LCS) is split into two branches by a beam-splitter (BS), sample (SMP) and reference (REF). In the detection branch a diffraction grating (DG) disperses the spectrum of the reflected light on a camera (CAM). Using digital signal processing (DSP) the height image of the sample is retrieved.

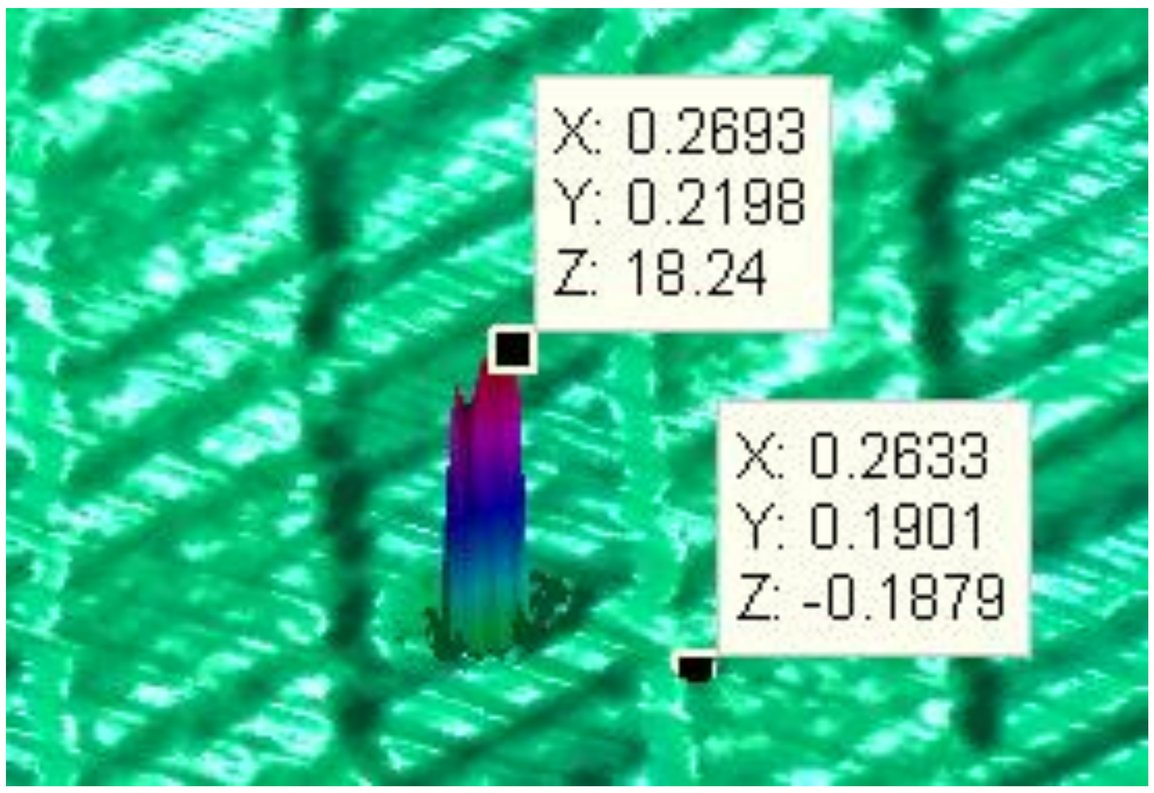


Figure 3: Proof of principle measurement of an 18.4 µm high particle on a patterned surface, demonstrating that the surface structure does not influence the height measurement.

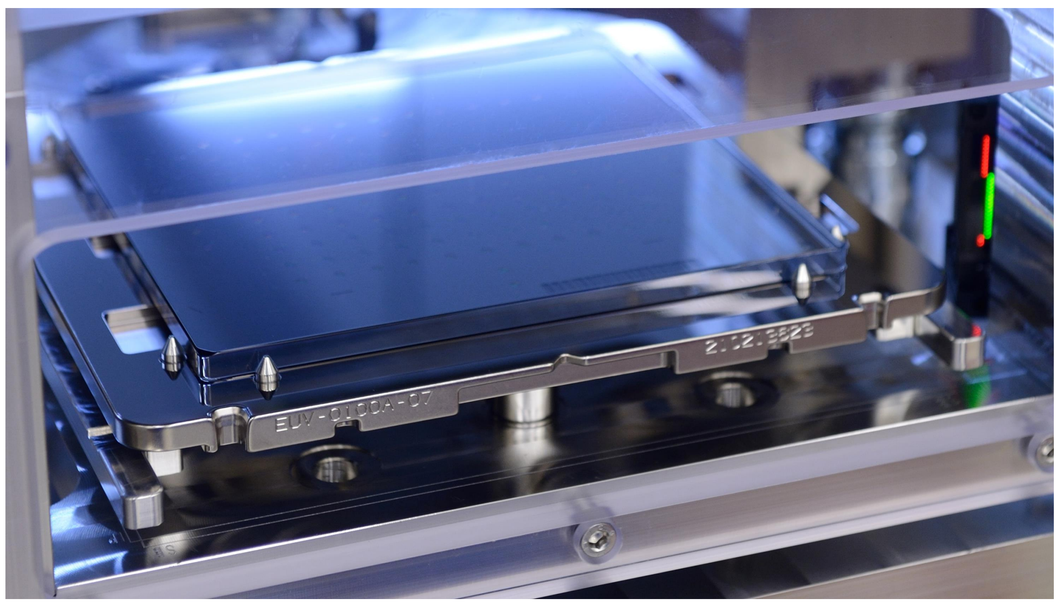
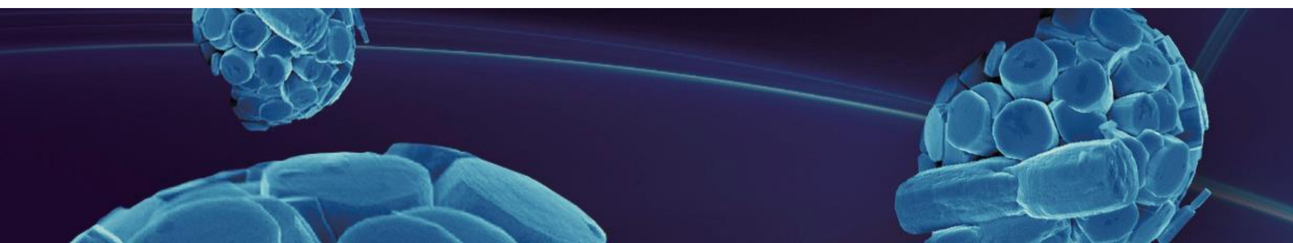


Figure 4: Inspection on the inner-pod base-plate exposes only the reticle back-side, while protecting the front-side.

REFERENCES
1. Rik Jonckheere, Tobias Waehler, Bart Baudemprez, Uwe Dietze, Peter Dress, Oliver Brux and Kurt Ronse , “Integrated cleaning and handling automation of NXE3100 reticles”, SPIE 8352 (2012).
2. Obert Wood, Emily Gallagher, Louis Kindt, Monica Barrett, Hirokazu Kato, Uzodinma Okoroanyanwu, Jeffrey Schefske, Ananthan Raghunathan, Tom Wallow, John Whang, Carol Boye and Sumanth Kini, “Impact of frequent particle removal on EUV mask lifetime”, EUVL (2010).



This work has been performed in the framework of the International Center for Contamination Control, established by TNO. Partners are welcome to join ICCC in the challenging development of dedicated contamination control solutions.